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Petrobras: Innovation with Party Rent-Seeking

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Abstract: The Brazilian oil company Petrobras is a leader in the technically challenging offshore oil exploration and an innovation pioneer in this segment. In the last ten years it has discovered enough reserves to put Brazil in the group of oil exporters while serving as an anchor of an industrial policy focused on increasing domestic procurement of capital goods. These achievements made the company a poster child of developmentalists, an example of a state company that innovates and invests in long-term projects. However, recent corruption investigations revealed that former employees, suppliers and politicians were involved in a billionaire kickback scheme that used the company for illegal campaign financing and coalition-building. This paper explains the puzzle of Petrobras' as a technological leader at the same time that it was the center of party-clientelistic practices. It argues that given Brazil's geological endowments, Petrobras could better serve open political purposes if the company continued to create rents through Schumpeterian innovation in deep offshore. Innovation supported Petrobras' other activities, which later included politically-driven investments, bribe extraction, and gasoline price subsidies. Using a variety of data sources, including plea bargain statements and a spreadsheet of bribe rates of large projects, this paper shows how bribes and economic losses differed across industry segments, with the downstream concentrating more losses than the more innovative and subject to cost pressures upstream. Petrobras' operational capabilities and a track-record of innovation in oil extraction led to successful discoveries of new reserves that paradoxically facilitated political interference by easing historical constraints that had spared the company from political exchanges.

Key words – National Oil Companies, industrial policy, corruption, innovation, resource curse

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1. Introduction

In November 19 of 2015, Pedro Barusco, a former senior manager of Petrobras, left his home in Rio de Janeiro, where he was serving house arrest, to provide testimony to a congressional hearing in Brasília. He became a public figure that year for his role in the Petrobras corruption scandal because he alone amassed $100 million in a Swiss bank account in kickbacks from suppliers. Barusco signed a plea deal with prosecutors and agreed to return all those bribes. Federal deputies wanted to question him directly about the shady deals at Petrobras which resulted in huge losses including to public pension funds, the topic of the enquiry committee.

In the hours-long hearing, the deputy Raul Jungman (PPS-PE) said that he wondered why Barusco, a career professional without political connections and with a stable and well-paid job in Petrobras, started to receive bribes. “How was the first bribe?” he asked. Barusco mentioned his previous role as technology manager in the prestigious research center of Petrobras, Cenpes, where he helped to develop innovations for deep offshore production working in close collaboration with the Dutch company SBM. In his account, the solutions that he helped to develop had been so successful that the local representative of SBM was receiving piles of cash bonuses from the company headquarters. Barusco claimed that the executive, who became his friend after years working closely together, offered him a share of the bonuses, on a personal basis.

The year was 1997 and, at the time, no quid-pro-quo was involved. However, starting in 2004, a sophisticated kickback regime to support corrupt executives of Petrobras and political parties took shape. By that time, Barusco was working as a deputy of Renato Duque in the directorate for Services and Engineering, an area responsible for most of Petrobras’ procurement. In the years elapsed, Brazil’s oil production almost doubled: it went from 0.868 million barrels per day (mmbd) in 1997 to 1.5 mmbd by the end of 2004 (BP 2016). And the key to success had been the development of deep offshore reservoirs, thanks in great part to advances made in Cenpes, where Barusco started his career.

The story that Barusco told congressmen highlights an aspect that makes the Petrobras case stand out from the traditional association that exists between oil rents and corruption. Brazil’s geology was challenging for oil production – most reserves are located in costly and hard-to-access deep offshore areas, to which in many cases technology was not available off-the-shelf. Petrobras invested heavily, over the years, in technology and in developing suppliers in order to tap these resources, becoming an innovator and a world leader in deep offshore oil. This success led to the multiplication of

production and reserves, creating enough surplus to attract rent-seeking behavior by political parties, suppliers and its own employees. The development of suppliers and new solutions also created bonds between managers and suppliers, with the former being recruited to serve a corruption scheme.

In hindsight, Petrobras was among the least likely National Oil Companies (NOCs) to fall prey to political meddling and widespread corruption. First, it has an above average governance structure for a NOC, with shares listed on multiple stock exchanges (including in the United States) and a board that includes independent members, as well as auditing and transparency requirements equal to those of public companies (Musacchio and Lazzarini 2014, Tordo et al. 2011). Its shares were pulverized into many investors, including Brazilian workers who used their savings accounts (FGTS) to buy shares of the company. Such broad ownership would be expected to create constituencies to monitor the performance of the company and defend it against political predation (Shleifer and Vishny 1998). Second, since the Brazilian oil sector opened to private companies in 1997, Petrobras has operated in a competitive domestic environment and internationalized to explore oil fields in numerous countries, including in the U.S. Gulf of Mexico (Oliveira 2012). Transitioning from a government monopoly to a firm operating in a competitive market would also lead to an expectation of more efficiency and lower rent-seeking.

How to explain the puzzling fact of Petrobras as a leader in technological development of offshore resources, above average governance structure for NOCs, while being at the center of the largest corruption scandal of the history of Brazil? I explain this phenomenon as a process of innovation with rent-seeking, where policymakers are interested in both promoting innovation and appropriating the rents from it. I first provide a theory that connects geological endowments with political incentives, firm behavior and institutions related to the resource sector. It explains why Petrobras stands out as a leader in innovation in Brazil and within other NOCs and why it was more pressured to develop suppliers. This goes in opposite direction to rent-seeking models which assumes that rent-seeking uses inferior technologies to facilitate transfer to private actors (Tullock 1990) or that rent-seeking is linked to lower innovation activities (Murphy et al. 1993).

Instead, the argument defended in this paper is that Petrobras could more aptly serve political purposes if the company continued to *create* rents through Schumpeterian innovation by tapping ultra-deep water resources. Therefore, innovation was preserved in the institutional rules of the oil sector and within Petrobras since it has been vital to support the company's other activities, which later included politically-driven investments, illegal funding to political parties, and gasoline price subsidies

driven by political reasons. While corruption took place in all segments of the company, I show that it was much higher in the downstream (e.g. refining) than in the upstream (extracting oil). Not only the bulk of innovation of Petrobras was concentrated in the upstream, but the segment is also more subject to competitive pressures, whereas in the downstream distributive demands are more intense and take the form of energy subsidies and politically motivated investments of refineries and petrochemical plants.

This paper is organized as follows. In Section 2, I elaborate a theory of innovation in natural resource-sector that connects geological endowments with political incentives, firm behavior and institutions. Section 3 discusses how Petrobras worked over the years to innovate in deep offshore oil production in response to Brazil's complex geology. Section 4 addresses the corruption scandal of Petrobras and provides quantitative tests of losses by segments. Finally, Section 5 concludes and discusses the implications of the findings.

2. Geological endowments, innovation, and political incentives

This section will advance two arguments based on a theory that connects geological endowments with political and business incentives. First, I establish that because of Brazil's geological endowment, policymakers had an incentive to invest in rent-creation strategies in the upstream, departing from the conventional case of oil wealth serving as a source of easy rents that are captured by governments. Second, I show that the development of high-cost oil resources, such as ultra-deep reservoirs, has a higher demand for capital and operational expenditures, meaning that for the same unit of output (a barrel) more money is spent in purchasing goods and services, such as drilling rigs and production platforms, than conventional producers. This means that firm-supplier relationships are more important in countries abundant in high-cost/unconventional resources.

With the exception of the US, sovereign states own subsoil rights and, therefore, play a fundamental role in all aspects related to petroleum resources (Tordo et al. 2009). However, abundance of oil has long been viewed by the resource curse literature as something potentially negative due to its economic and political effects. Political economy explanations for the resource curse claim, in short, (a) that oil production is a source of high rents; (b) those rents tend to flow to the ruling class because of government ownership of subsoil rights; and (c) access to easy money generates soft-budget constraints and wasteful redistribution, unless the ruling class is institutionally constrained by checks-and-balances

(e.g. Collier 2010, Karl 1997, 2007, Robinson et al. 2006). As Kolstad and Wiig put it, "The resource curse is not about resource abundance per se, it is resource rents"(2009, p. 5324).[1] Yet, surprisingly little attention has been paid to a careful analysis of how the different types of rents and geological endowments affect political calculations and, in their turn, the institutions associated with the resource sector and the political coalitions that support those institutional arrangements. The literature ignores variations that arise from different geological endowments because it assumes, implicitly or explicitly, that oil necessarily generates high rents (for instance, Ross 2012) or because it claims that geology does not matter to key institutions of the resource sector (Luong and Weinthal 2010). If rents are critical to understand how resource-wealth will affect political actors, geology has to be taken into account since different endowments will result in varying levels of rent availability and technical challenges.

Rents are described as "payments made to a factor of production that are in excess of what is required to elicit the supply of that factor" (Stiglitz 1993). Three types of rents have been commonly applied to understand the oil sector: scarcity, differential (or Ricardian), and monopolistic. Exemplifying them: hydrocarbons are a scarce commodity, their production costs can vary from country to country, and OPEC oil exporters attempt to restrict output to increase prices – examples of scarcity, differential, and monopoly rents. In comparison, entrepreneurial or Schumpeterian rents originate from innovations in the productive process that allow a company to have higher returns than its competitors. This can come from efficiency gains (cost reduction) or the supply of a different and superior good during the process of creative destruction. The production of an old commodity, such as petroleum, in a new way, for example by deploying advanced technology, fits Schumpeter's definition of innovation (Schumpeter 1942, p. 132), although the resource curse literature traditionally neglects the role of the oil industry as a source for innovation.

Schumpeterian rents are important in the O&G industry because through innovation it is possible to bring new resources to market or reduce considerably the operation costs of current producing areas. Crude oil can be produced from a variety of geological formations and can even be made using synthetic processes using coal or bitumen. Moreover, given the large differences of costs per barrel across producing regions, there is a large payoff for solutions that reduce the cost required to bring to market a barrel of oil coming from high-cost areas. For instance, according to data from the

[1] In fact, Ross (2012) and Andersen and Ross (2014) argue that the curse is a post 1970s phenomenon, when oil-rich countries renegotiated contracts with International Oil Companies (IOCs) or nationalized their resources, allowing them to dramatically capture more rents to their coffers.

International Energy Agency (IEA 2015), new projects in Iran, Iraq and Saudi Arabia are estimated to be as low as $11 per barrel. In contrast, deep offshore projects in West Africa or in Brazil's pre-salt layer are estimated to cost at least $50. Whereas conventional oil generates high rents (because of its lower cost of production) and can be produced from off-the-shelf technologies, unconventional resources are more expensive and trigger more demand for technological solutions, capital and operational investments, and skilled personnel.

The analysis presented so far allows us to derive clear expectations of the incentives that governments in countries with different resource endowments, and abilities to exploit different types of rents, will have. A government in a country that has abundant, easily accessible resources with low cost will have the most to gain, in monetary terms, by maximizing rent capture: taxing the O&G sector highly and if possible coordinating to restrict output. At the other extreme, a government of a country that is just marginally profitable in the production of such natural resource will have no rent to extract – high taxes cannot be charged or production will cost more than sales price. In addition, such a marginal producer has no market power to influence world prices (no monopoly rents).

Consequently, an administration of a less well-endowed country has few options to stimulate its domestic oil industry. Considering that geology is given by nature and its production is small enough so it cannot influence prices, and therefore both geology and prices are exogenous to domestic actors, the only variables that can partially be influenced by public policy are technology, tax levels and institutions that can reduce production costs and mitigate investment risks. A nation abundant with a resource that has high cost of production, rather than striving to capture rents, will first have an incentive to create rents through R&D, innovation and complementary investments. The importance of industrial demand for developing these resources can be highlighted by the fact that more money can be exchanged in the form of industrial and service contracts than in rents distributed by governments, particularly when selling prices become closer to break-even levels. This demand will be politically important as local supplier firms will have an incentive to lobby for rules that mandate that oil companies prioritize them in their procurement, what has increasingly taken the form of local content (LC) requirements as conditions to access exploratory areas (Lima-de-Oliveira 2016, Tordo et al. 2013).

Those distinct geological endowments and associated industry characteristics create incentives for political actors who are involved in setting the rules of the natural resource sector. The executive branch, as manager of national resources, is the first affected by these incentives. However, the executive faces political constraints that can be either distributive pressures, or veto points from the

legislative action (Krehbiel 1998, Tsebelis 1995), or both.[2] Resource endowments (volume of reserves and cost of production) provide direct incentives for the executive, which is interested in the revenues from oil production, and also affect interest groups by shaping their distributive demands and expectations about future costs and benefits. Considering that in high-cost oil production the demand for capital goods and services is higher, it is likely that pressures to include local suppliers in the production chain in the form of LC mandates will increase. Those mandates are not, in any way, necessary for the development of high-cost oil, and they may even be detrimental to it in terms of time and cost overrun. However, I expect it to arise due to the political benefits that such policy can confer to firms and lawmakers.

These incentives are related to the upstream part of the production chain – getting oil out of the ground at cost-competitive prices. However, (integrated) oil companies do more than just extracting oil: they can transport it (midstream), refine and transform into petrochemicals (downstream). Significant rents exist in the upstream (Tordo et al. 2011) but as the value chain moves from the discovery and production of oil to transformation (downstream), the market becomes more competitive and the margins tighter: a refinery essentially receives a commodity as feedstock (barrels of crude) and produces other commodities. Demand for technology is also lower, as the transformation process can use off-the-shelf technologies. On the other hand, distributive pressures can be very high and come from two main distinct sources: subsidized domestic energy prices, which are common in oil-rich countries (Cheon et al. 2013) and investments in refineries and petrochemical plants according to political convenience rather than technical feasibility, sometimes branded as regional development efforts (Ascher 2001).[3]

To sum up, resource endowments vary in their characteristics, rents per unit of output, and what it takes to extract them. All these generate political incentives on how to structure the institutions of the resource sector and the behavior of oil companies. Where natural resources are abundant and easy to extract, there will be little incentive to improve the efficiency of production or invest in technology or the supply chain. On the other hand, where resources exist but rents are few, an institutional arrangement to support rent-creation will facilitate the development of the natural resource sector.

[2] For instance, a coalition that is concerned about environmental impacts from unconventional oil production and is powerful enough to serve as a veto point can block production from this source of oil.

[3] While in the upstream oil production requires the existence of a reservoir in the first place, a refinery or a petrochemical plant can be disputed by different regions and political groups.

These are expectations across countries (between high-rents versus low-rents producers) and across time (as a country shifts its geological endowments). Furthermore, I also derive expectations for within industry sectors. Downstream operations lack the geological constraints that exist in the upstream and their innovation incentives. Additionally, it is more subject to political pressures in the form of domestic price subsidies and in its investment decisions. Table 1 summarizes the theoretical expectations concerning innovation and distributive pressures by resource type and industry segment:

Table 1: Industry segment, innovation and distributive pressures

	Upstream		Downstream	
	Incentives for innovation	Distributive pressures	Incentives for innovation	Distributive pressures
Conventional	Low, production is competitive with standard-technology due to favorable geology	Low from suppliers (low capital investments), high from internal stakeholders (employees)	Low, tight margins and commoditized production	High, localization of investments and cheaper energy prices. Limited by production capacity and (lower) reinvestment needs
Unconventional	High, needs to access complex reservoirs and reduce costs to stay on the market	High from suppliers (high capital investments) and low to moderate from internal stakeholders (limited by cost pressures)	Low, tight margins and commoditized production	High, localization of investments and cheaper energy prices. Limited by production capacity and (higher) reinvestment needs

To test the predictions generated in this section, I examine the Brazilian oil industry over time. I start by showing how Petrobras invested heavily in technologies to tap its complex geology of deep offshore fields. Brazil's market opening in the mid-1990s rather than dismantling Petrobras' innovation efforts and its developmental mission reinforced them by putting in place institutions to support further R&D investment and incentives to procure goods and services from domestic industries. Section 4 will then examine the origin of the Petrobras' corruption scheme and how it varied across industry sector, testing the prediction that in downstream distributive demands and rent-seeking are higher.

3. Petrobras: creating rents

Unlike traditional resource-rich Latin American countries like Venezuela, Ecuador and Mexico, Brazil was not blessed with an easy geology for hydrocarbon extraction. After an intense political campaign to nationalize the industry and develop the national O&G resources, Petrobras was formed in

1953, as an unusual NOC which had a monopoly of oil fields that where yet to be found, first in the world in that situation (Smith 1976). It was thus born out of scarcity with the mission to find and develop oil resources to meet domestic needs.

Oil production in Brazil started in onshore basins in the Northeast of the country but it soon became clear that these resources had limited potential. After years of mostly failed exploratory campaigns onshore, Petrobras took the strategic (and costly) decision to invest in offshore exploration. The first offshore discovery was made in 1968, in Sergipe, a small field named Guaricema, at 28m of water depth (Morais 2013). In purely economic terms, there was no reason to develop the field: a barrel in the international market was over three times cheaper than the cost of extracting it from Guaricema. However, the company decided to develop it thanks to long-term considerations of learning how to produce from offshore locations and military concerns that placed high value in energy security for developmental and defense purposes (Philip 1982). To achieve the objective of maximizing Brazil's oil potential, the military, which ruled Brazil from 1964 to 1985, also protected Petrobras from patronage practices that were common in other state companies and even Petrobras itself during João Goulart's administration from 1961-1964 (Geddes 1994, Oliveira 2012).

The strategic turn to offshore exploration paid off when significant resources were found in the mid-1970s in the Campos basin, off the state of Rio de Janeiro. First was the field of Garoupa (in 1974), followed by a stream of discoveries of nearby fields (Dias and Quagliano 1993). After drillings confirmed the oil potential of the new discoveries, Petrobras had to prepare the long-term production structure and studied different offshore systems to put these fields into production, acting first as a "smart buyer" of technological solutions. For instance, after surveying different possibilities of platforms being used in the world, it settled for a floating, production, storage, and offloading (FPSO) facility to develop its Garoupa field – the second company in the world to adopt this type of solution, after Shell (Priest 2016).

With new discoveries in the coast of Brazil and the need to go further offshore, Petrobras strengthened its project management capabilities and became an active developer of technological solutions – in partnership with suppliers and research centers, both from Brazil and abroad. Its R&D center, Cenpes, founded in 1966, begun as a unit that did mainly technical assistance and technological transfer, but gradually evolved to equipment engineering and indigenous research with a well-funded budget (Randall 1993). Cenpes launched in 1986 a technological capability program for deepwaters with a clear target: be able to extract oil at depths up to 1000m (Procap 1000). To achieve this goal, researchers had to master subsea solutions that were at the international frontier of the industry at that

time. The initiative was followed by a second similar program in 1992, with the goal of achieving capabilities to produce from water depths of up to 2000m (Procap 2000), and a third one, in 2000, to produce from water depths of 3000m (Procap 3000). To Morais (2013), while the bulk of the Procap 1000 projects could be characterized as incremental innovation, later editions were significantly devoted to radical innovation.

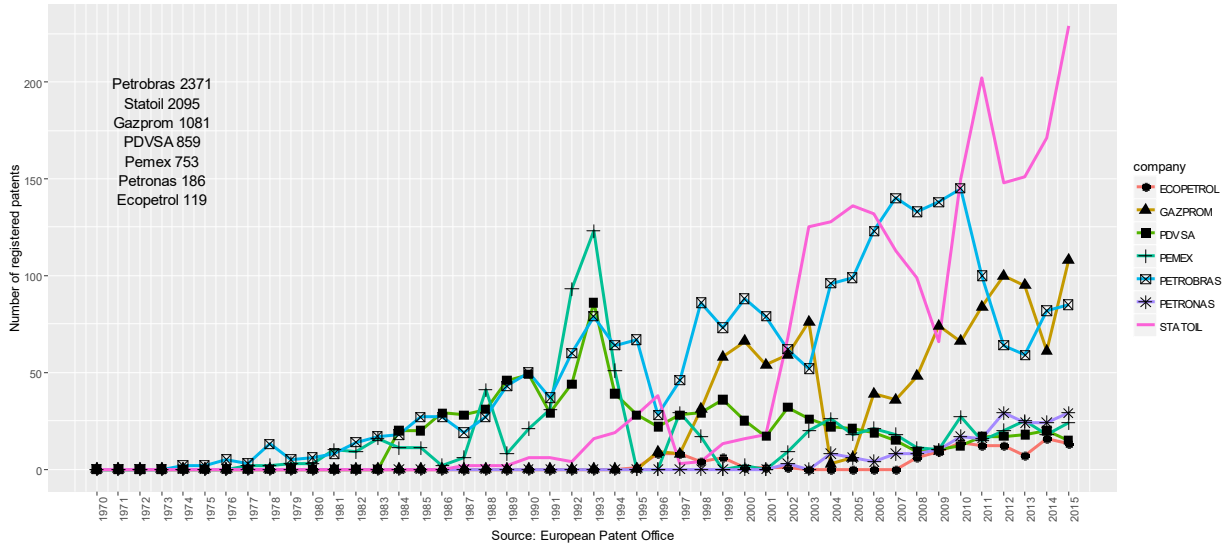


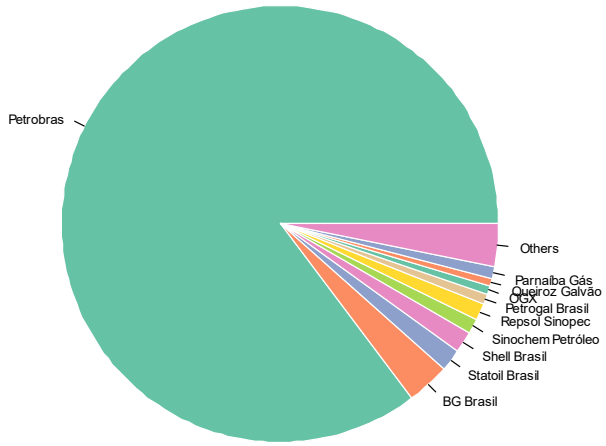
Figure 1: Patents registered by selected NOCs (1970-2015)

Thanks to Procap and the knowledge networks that Petrobras built with suppliers and research centers, the company progressively went further offshore, registering some of the world records for deep water oil operations. The achievements were recognized by the world industry and Petrobras received three times the Offshore Technology Conference (OTC) Distinguished Achievement Award (1992, 2001, 2015), a prize that exist since 1971 and no other NOC has ever been awarded.[4] To Priest (2016), the proper comparison to Petrobras is not other NOCs created to manage national resources that were known to exist in abundance, like PDVSA, Pemex, and even Statoil, but rather Shell Oil, an offshore oil pioneer. In fact, comparing patent data of NOCs (Figure 1) – a crude but widely used indicator of innovation activities – reveals that Petrobras has more patents registered (2371) than other

[4] The award has been given to universities, suppliers, and oil operators. Shell currently leads the number of awards with five recognitions (1971, 1982, 1998, 2004, 2012). See OTC (2016).

NOCs which enjoyed higher levels of oil production. It is seconded by the Norwegian Statoil (2095) – a company that also had to operate under the challenging conditions of offshore oil production.

In spite of its technical achievements, by mid-1990s Brazil was still importing about 60% of its oil needs. A reformist government in 1995 ended the Petrobras oil monopoly in Brazil through a Constitutional Amendment, allowing the federal government to license exploratory areas to other companies. In 1997, the Congress approved a new legal framework which created a regulatory agency (ANP) charged with overseeing the sector and conducting bidding rounds for exploratory areas. With the end of the monopoly of Petrobras, the government was free to select other companies to explore and produce oil in the Brazilian territory. Since 1999, ANP has been conducting bidding rounds offering areas for exploration, open to any qualified company. However, Petrobras kept a de facto monopoly of oil production given its technical capabilities and deep knowledge of Brazil's geology. While majors like Shell, Statoil, and Chevron extract O&G in Brazil with their own platforms, their market share is small. Nevertheless, in many fields, including in the pre-salt, Petrobras works in partnership with other companies, which had been critical to raise capital for deep offshore development, helping to consolidate Brazil's leadership in this segment. Taking into account the participation of partners in the oil production, the market share of Petrobras was 85% as of 2014 (Figure 2).



Source: ANP

Figure 2: Oil and gas production by concessionary in Brazil (2014)

When Brazil opened its oil sector, lawmakers and regulators adopted two regulatory provisions that are particularly relevant for industrial demand and innovation. The first is a contractual clause that

earmarks 1% of the gross revenues collected from highly productive fields to R&D. Up to half of that amount can be invested in internal R&D centers (such as Cenpes, for Petrobras) or by private partners with R&D operations in Brazil. The remaining has to go to nonprofit institutions, such as universities accredited by ANP. From this source alone, over R$15 billion have been invested in R&D for the domestic energy industry from 1998-2015.[5] However, this source represents only the minimum legal requirement. From 2001 to 2014, Petrobras invested over $10 billion in R&D (Petrobras 2015), or about R$32 billion.

Another important – and controversial – clause is a LC requirement which stimulates oil companies to procure from suppliers located in Brazil (be they multinational or domestic companies). Since the first round of bidding, ANP considered LC investments as criteria for selecting winners, along with signature bonus (cash payment) and a minimum exploratory program (the amount of investments the firm commits to do in the exploration phase, such as seismic acquisitions and drilling of wells). The weight of local content and how it is defined, however, changed over time: it has been strengthened over the years due to pressure from domestic business associations. Starting in rounds 5 and 6 (2003-2004), LC became mandatory and from round 7 onwards a rigorous certification system was put in place, where items and sub-items have to be measured in their specific degree of national value added by third-party auditors accredited by ANP. An official ANP booklet describes the items and sub items and the minimum expected local content value for each. Penalties for not complying were also raised and so far ANP has collected over R$ 350 million (about $110 million) in fines for operators who failed to meet the targets (Lima-de-Oliveira 2016).

The long-term innovation strategy and partnerships with other oil companies paid off when in 2007 was announced the discovery of the “pre-salt” reserves in the Campos and Santos basins. The first field to be discovered was Tupi (later renamed to Lula), originally a consortium of Petrobras (65%), BG (25%), Galp (10%). More oil discoveries followed, characterizing a new abundant oil province (Morais 2013), with initial estimates as high as 70 billion barrels of oil, multiplying Brazil’s oil reserves at the time (12.6 billion barrels). However, developing the pre-salt resources came with high costs and technological hurdles, given that operations are 300 km offshore and at water depths of 2,000 meters or more.

[5] Author’s calculation based on data from ANP (2016). Past amounts were corrected for inflation. For comparison, this amount represents about half of the total cost of hosting the 2014 World Cup, including the building and reform of stadiums, metros, and airports (R$ 27.1 billion).

Deep offshore oil production is not only technically challenging – it is a highly capital intensive operation. The development of a medium-sized offshore field costs approximately $1 billion (Jahn et al. 2008). Deep offshore wells are particularly expensive to drill: just the drilling activity can cost $100 million. In addition, costs tend to rise with water depth. The trend in Brazil has been of going deeper and deeper in terms of oil production. In 2015, 82% of Brazil's oil production originated from deep offshore fields, while only 6% of the world's oil came from this source in 2011 (IEA 2012). Taking into account oil production by field and averaging it by water depth, in 1995 a barrel in Brazil was produced from wells located at 464m, while in 2015 it was of 1257m (Figure 3).

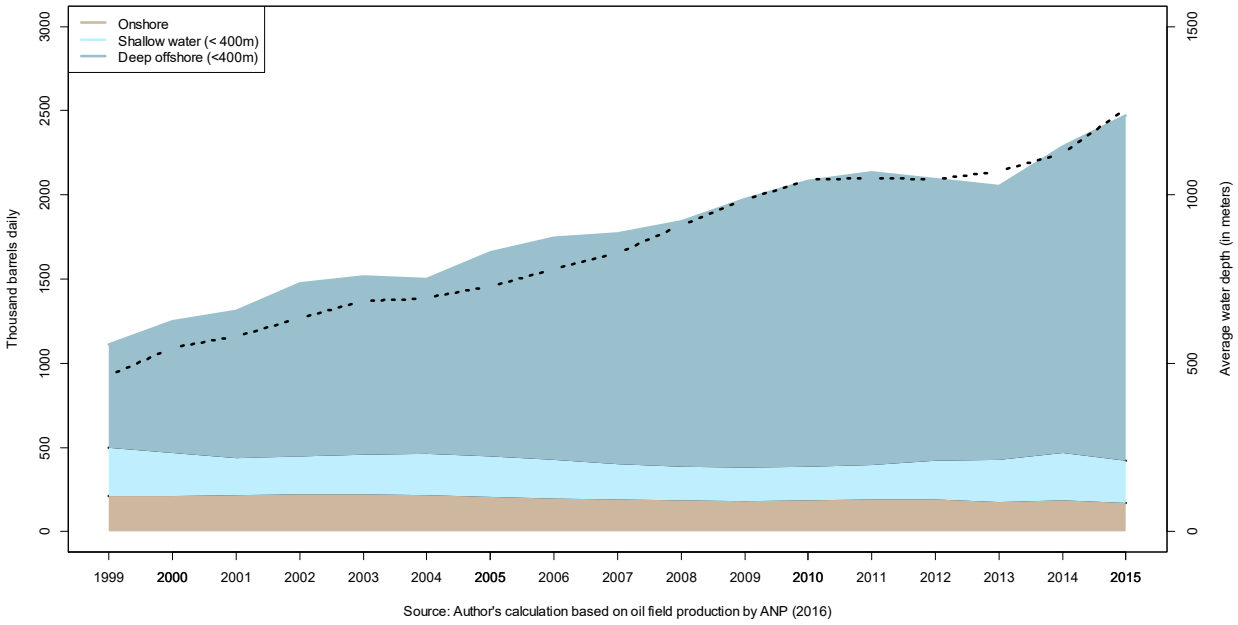


Figure 3: Brazil's oil production and average water depth

The spectacular growth of production and water depth required record levels of capital investments – financed, in part, by partner oil companies, Brazil's public banks (Almeida et al. 2014), issuance of public debt and stockholders. Figure 4 displays, in 2015 dollars, the spectacular growth of capital investments made by Petrobras after 2004. From 2004 to 2015, Petrobras invested $335.848 billion, almost four times what it did in the previous 50 years of its history, which sums to $87.3 billion. However, not only Petrobras boosted investments in petroleum exploration and production (E&P) as would be required to develop the newly found resources of the pre-salt, but also in all other areas of the

company, notably downstream, electrical energy, petrochemical and international investments. In fact, the share of upstream investments decreased from a peak of 92% registered in 1984 to a low of 42% in 2010 - the smallest share since 1976.

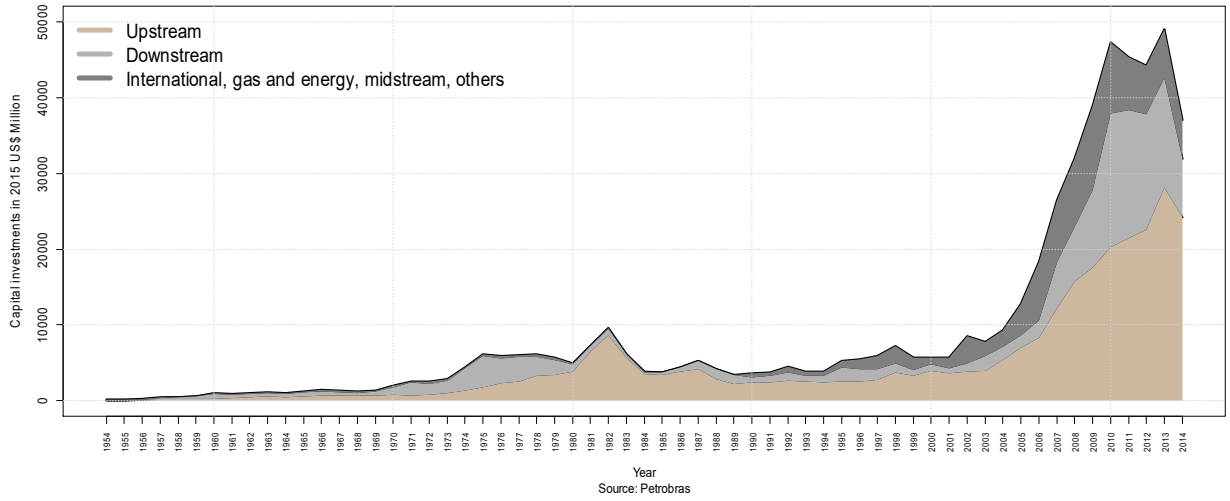


Figure 4: Total investments by Petrobras (1954-2014) in 2015 US$

Domestically, the discovery of the pre-salt polarized policymakers. The ruling coalition, led by the Worker's Party (PT), emphasized the feat as the result of years of state activism and a long-term strategy of innovation, backed by the patient capital of the state, just as suggested by Mazzucato (2014). The government, with support from its large party coalition, put in place a more restrictive regulatory framework specifically for the pre-salt area that granted the monopoly of operations to Petrobras (Lucas 2013), while still letting private partners to participate as equity investors. Others viewed the achievement as the result of a well-designed regulatory rules that kept in place incentives and funding for R&D, promoted bidding rounds open to any company and allowed Petrobras to partner with private firms (Fernández 2013, Pires and Schechtman 2013). The debate was intense and played out in the public sphere, but what was unknown to the public was that Petrobras was being used as a major source of bribes for the ruling coalition and its senior management. As later revealed by a police operation, each of the major investments of Petrobras since 2004 carried a bribe to fund political parties.

4. Oil rents greasing the wheels of coalitional presidentialism

4.1. The “Carwash” operation

In march of 2014, the Brazilian Federal Police started to investigate a money laundering scheme that was based in a fuel station. The operation was dubbed “Carwash” and led to the temporary arrests of politicians, company executives, and bagmen, with intense press coverage. The investigation revealed that a former director of Petrobras, Paulo Roberto Costa, had close ties with Alberto Yousseff, the actual target of the investigation and responsible for running a money laundering and bribe scheme that connected contractors to politicians and Petrobras’ executives. After been arrested, Costa and Yousseff negotiated plea bargains with public prosecutors and decided to reveal the full extent of the scheme, leading to further arrests, including some of the wealthiest businessmen in Brazil. Each new round of the police operation led to more arrests, with some executives and CEOs of companies deciding to collaborate in exchange of reduced sentences. A notable case was of Pedro Barusco, from Petrobras, who agreed to return $ 100 million he had in a Swiss bank account.[6]

The operation revealed a cartel of construction companies who overcharged Petrobras in exchange of paying bribes ranging from 1% to 3% of the total contract amount. In an elaborated scheme that lasted for years, executives of big national construction companies held periodic meetings to fix public biddings. A share of the overcharged amount would then be split between senior managers of Petrobras and political parties. This was made possible because, starting with Luiz Inácio Lula da Silva administration (and persisting under his successor, Dilma Rousseff), political parties of the governing coalition were put in charge of appointing senior managers of the company.

With few exceptions, the management of Petrobras continued to be run by highly qualified longtime employees who entered through open, competitive examination. However, in order to reach and hold a position of direction, an employee had to court the active support of a political party, such as PT, PMDB, and PP. In exchange, each technical made political appointee helped their backing parties (and political bosses) by extracting bribes from contractors and channeling resources to their patrons in the form of official campaign donations and off-the-book money. In the operation, they also enriched themselves by keeping a share of the bribes. Promotion, thus, required both technical ability and lack of moral standards.

For instance, Paulo Roberto Costa, who was the Petrobras downstream director between 2004 and 2012, entered Petrobras in 1977 after graduating in mechanical engineering. He has worked for

[6] For a chronicle of the operation see Netto (2016).

years in the company's most important production assets, slowly rising within the company. In order to become a director, a position with its power and perks similar to oil majors, he sought a political patron. José Janene, a federal deputy and leader of PP, backed his name in exchange of access to Petrobras' suppliers and bribes. According to Costa's plea bargain testimony, he usually collected a 3% bribe for contracts in the downstream.[7] Two thirds of the amount went to PT – the ruling party. From the other 1%, 60% of it was directed to PP, 20% was split between himself and Alberto Yousseff, and the remaining covered the costs of money laundering. As his directorate became more important with increased investments (and bribing opportunities), Costa felt that his position was under menace by other parties that pressured the executive to appoint a new director. He then started to broaden his political support, collecting bribes to others parties as well, such as PMDB.

Another key player of the scheme was Renato Duque, the director of Engineering and Services. He entered in the company in 1978 and before being selected to occupy a directorate (between 2003-2012) he was a manager of contracts in the company. His party link was directly with the PT. Duque selected as deputy Pedro Barusco, who since 1997 received bribes on a personal basis, and was put in charge of running the kickback scheme. Similar to Costa and Duque, other directors such as Nestor Cerveró and Jorge Zelada, all jailed in the course of the investigation, were longtime employees of Petrobras who became directors due to party links and had close ties with suppliers. For external observers, the company continued to be run by professional career employees.

One exception to this rule was Sérgio Machado, a politician who occupied from 2003 to 2014 the presidency of a subsidiary of Petrobras, Transpetro. A former senator with no experience in the oil sector, Machado was appointed to the position by the PMDB. In his statement to prosecutors, he was blunt about how he saw his mission as CEO of Transpetro. He claimed to follow two guidelines: extract the maximum possible efficiency of Petrobras' contractors, both in quality and price, and extract the maximum amount of bribes to pass on to politicians who ensured his political appointment.[8] He was in charge of an ambitious industrial policy program to support the creation of new shipyards through a government procurement policy of renewing the fleet of oil tankers of Petrobras, with a minimum local content of 65% (Petrobras 2013).

[7] Collaboration statement n. 26 by Paulo Roberto Costa (09/02/2014). Available at http://politica.estadao.com.br/blogs/fausto-macedo/leia-os-35-depoimentos-do-ex-diretor-sobre-corrupcao-na-petrobras/

[8] Collaboration statement n. 1 by Sérgio Machado (05/04/2016).

The revelation of the scandal raised an immediate problem to the company and its auditing firm, PwC: Petrobras' book value was not reliable. Due to the confessions of executives who entered plea bargains that the price tag of large investment projects included the payment of bribes, the balance sheet of Petrobras counted as the value of productive assets what really was the cost of corruption. PwC refused in late October of 2014 to sign the company's third quarter results until the cost of corruption was written-off. The team of Petrobras and hired lawyers worked for months to release an estimate of the total cost of corruption. It ultimately took into account the testimonials and data collected from the plea bargains made during the "Carwash" Operation and deduced from 1% to 3% the value of projects cited in the corruption scandals. Petrobras also performed an impairment test, which compares the book value of projects with its fair value. On April 22 of 2015 the company was finally able to publish audited financial results. It registered a significant impairment charge and a write-down of improperly capitalized additional spending (bribes). The result was a loss of R$ 21 billion (US$ 7.2 billion) in the 2014 financial statement, the first negative result of Petrobras since 1991.

With the information now available, it is possible to investigate the sources of losses of Petrobras and how it varied within industry sector. While corruption existed before in Petrobras – and the statement of Pedro Barusco about his first bribe shows that – the evidence points to 2004 as the beginning of a systematic usage of the company to serve Brazil's coalitional Presidentialism. Consequently, it was after Petrobras had mastered production from deep offshore oil and output levels were rising consistently. Within sector, the theoretical expectation is that rent-seeking will be higher in the downstream, which has stronger distributive pressures in the form of price subsidies and localization of investments. On the other hand, the upstream is the only segment directly affected by an industrial policy of LC requirement which partly protects the Brazilian industry from free imports and it is conceivable that such political protection could lead to higher bribes. The analyses that follow is divided into three topics: a) direct cost of bribes; b) politically motivated investment decisions that resulted in losses recognized in the balance sheet; c) resources spent on gasoline and diesel price subsidies.

4.2. Direct costs of bribes

In studies about corruption it is rarely the case that a researcher has access to direct evidence and is able to compare the cost of corruption and factors that influence the level of corrupt behavior (McMillan and Zoido 2004, Olken and Pande 2012, Treisman 2007). In the case of Petrobras, it is

possible to compare which projects paid the highest amount of bribes and what where the mechanisms of payment and negotiations between corrupt executives, politicians and contractors.

Data for this subsection comes from the previously confidential statement of Pedro Barusco. Among the documents that he gave to the Federal Police and public prosecutors was a spreadsheet with 88 large projects under his supervision, with detailed information on the project type, date, the total amount, the bribe rate, the companies involved, and how the bribe was to be split. Barusco's division was responsible for the bulk of large projects of Petrobras, although some projects were directly contracted by other divisions, such as the International, Gas and Energy and Downstream directorates. Therefore, although this spreadsheet does not cover all the corruption found in Petrobras, it covers a large part of it. This evidence is supplemented by Barusco's own statement to congressional committees (*CPI da Petrobras and CPI dos Fundos de Pensão*), statements made by others suspects who entered in leniency agreements, petitions made by public prosecutors and judicial decisions.

The data is particularly useful to test whether the industrial policy decision to procure parts of the capital goods locally resulted in more bribes. The LC policy creates incentives to the development of indigenous industries by protecting domestic markets against free imports of goods, like drilling rigs, oil platforms and subsea equipment. It typically imposes quantitative targets to be met by oil operators in the upstream, like a requirement that 55% of an oil platform be built using goods produced domestically, as is the case in Brazil. Oil operators that cannot comply can petition for waivers when the domestic market is unable to meet the demand or pay fines if they opt to not fulfill the requirement. The LC policy establishes a global goal but allows for the oil operators some room of maneuver to manage the achievement of the target or to escape the policy requirements under certain conditions.

Thirty-five companies are listed in the dataset[9], of which eight are international or local subsidiaries from a variety of countries.[10] The spreadsheet has a variety of projects from 2003 to 2010, including: parts of two new refineries and upgrades of existing ones, gas pipelines, local headquarters, expansion of Petrobras' R&D center, oil platforms. The last group of item is the only one directly affected by LC, while all others have no binding mandate to fulfil a specific target of domestic purchase.

[9] Alusa, Andrade Barbosa Melo, Gutierrez, Bueno, Camargo Corrêa, Carioca, CNEC, Contreras, Construbase, Construcap, EAS, EBE, EIT, Engeform, Engevix, Floatec, Galvão, GDK, Keppel Fels, Mendes Jr., MPE, OAS, Odebrecht, Odebei, Promon, Queiroz Galvão, Quip, SBM, Schain, Setal, Skanska, Techint, Tomé, Toyo Setal, UTC.
[10] Argentina (Contreras), Sweden (Skanska), Japan (Toyo), Singapore (Keppel Fels), United States (Quip), Nederland (SBM), Italy (Techint), Germany (Hotchief). CNEC was originally a Brazilian company but was acquired in 2010 by the Australian group WorleyParsons. CNEC appears in Barusco's spreadsheet in a 2009 contract in consortium with Camargo Correa, thus one year before it was acquired.

It is possible, therefore, to compare the bribe rate of products where Petrobras had the incentive to procure domestically due to LC versus others which the company freely contracted. Barusco's accounting lists only projects where the bribe rate ranged from 1% to 2%, while in the statement made by the former director of downstream, Paulo Roberto Costa, bribes were as high as 3%.[11] If anything, the difference between the downstream and upstream segment will be understated, since the projects handled by the downstream director had a higher bribe rate. In contrast, oil platforms and drilling rigs, LC requirements, pertain to the upstream segment.

Another difference between contracts from the LC requirement and other activities of Petrobras is that platforms, drilling rigs and their components are priced in dollar. These are tradable goods, with international price and suppliers, while domestic construction services hired by Petrobras are priced in Brazilian reais (BRL). Although they can have imported components, construction services are purchased domestically and paid in BRL. On the other hand, capital goods for the offshore oil industry follow closely international maritime and safety standards and can be exported, as they currently are.[12] These goods are mobile, standardized, and provided by a competitive international market where price differences can easily be spotted.

Construction services, especially in complex projects, have more room for customization. Specific terrain challenges, availability of local infrastructure and climatic events contribute towards losses during construction that can be contingent and variable. These characteristics of being unique goods facilitates over-invoicing and overpayment because it is more difficult to detect bribes (Shleifer & Vishny 1993). Accordingly, in political economy models of bribe extraction, bureaucrats are assumed to choose optimal bribe rate taking into account market forces and the probability of being caught (Olken and Pande 2012, Shleifer & Vishny 1993). These factors would lead us to expect that bribes in the tradable goods (predominantly in the upstream) would be lower than in other segments of Petrobras, such as building new refineries. To test this hypothesis, I regressed the data of bribe rate on the type of contract, which is a dummy for tradable goods. Figure 5 presents the difference of means of the variation on bribe rate with confidence intervals:

[11] Costa was appointed to the board of Petrobras by politicians from PMDB and PP, and the additional one percentage point on bribes from his directorate was used to channel resources to himself and these parties. The lion's share of corruption in Petrobras was within the engineering directorate, which had bribes split between PT and the employees appointed by PT leaders.

[12] Oil tankers and platforms built in Brazil are formally exported out of the country and then imported as part of a tax break regime called *Repetro* that was created in 1999.

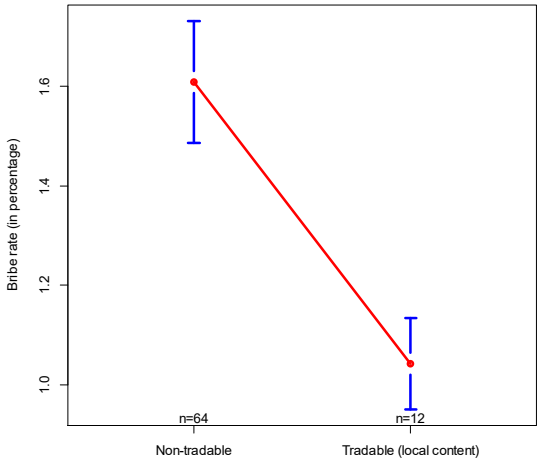


Figure 5: Variation on bribe rate

Full regression results are displayed in Table 2, where I also control for the value of the contract.[13]

Table 2: Variation on bribe rate

	Model 1	Model 2	Model 3
Intercept	1.60***	1.55***	1.43***
	-0.061	-0.077	-0.087
Tradable/LCP	-0.567***	-0.71***	-0.41***
	-0.073	-0.07	-0.092
Contract value (in 100 million BRL)		0.11	0.304***
		-0.065	-0.07
Tradable/LCP*Contract value			-0.29*
			-0.07
Adj. r-squared	0.16	0.2	0.25

Robust standard errors in parentheses

As is possible to see, results are statistically and substantively significant and in line with the theory outlined here.[14] Non-tradable goods, that operate in a more competitive market even when

[13] Contracts priced in dollar were converted to BRL using the currency exchange rate of the day the contract was signed. In the list, R$ 48 billion of projects are priced in BRL and US$ 10.7 billion in dollars.
[14] From the 88 fields, there is missing data on bribe rate for 12 projects – only one related to the upstream segment and quoted in dollars, a contract with the Dutch SBM.

benefited by a LC policy, paid less in bribes than other contracts made by Petrobras. Model 2 shows that contract value is significant at the 10% level (t = 1.77). Once an interactive term is added, as is done in Model 3, contract value is also significant at the 1% level (t = 4.34). For a contract of R$ 100 million, the predicted bribe rate from Model 3 is of 1.73% for non-tradable goods (1.43 + 0.304 = 1.734) and 1% for goods purchased under LC rules (1.43 – 0.41 + 0.304 – 0.29 = 1.034). Given the interaction effect, higher contract values show the bribe rate of non-tradable goods increasing faster than goods purchased under LC. This suggest that there are more rents to be shared with politicians and Petrobras' executives outside of the upstream segment, despite its LC policy.

Statements made by Barusco to the Federal Police and to the congressional inquiries that investigated the Petrobras scandal corroborates that interpretation. The data presented above refers to contract made directly by Petrobras, but the state company helped to set up a new company specifically to purchase new drilling rigs to exploit the pre-salt area, Sete Brasil, formed in 2010. Barusco was one of the first executives of Sete Brasil after retiring from Petrobras. According to him, he had tough negotiations with national shipyards in order to bring prices to international standards. Sete Brasil was designed to be a portfolio manager of O&G assets and signed contracts to lease 28 drilling rigs to Petrobras, with the commitment of purchasing them in Brazil, following the LC policy. Sete Brasil's total investment was projected to be US$ 25.7 billion. According to Barusco, bribe rates in the Sete Brasil contracts were reduced to less than one percent in some cases in order to bring prices closer to Asian producers and due to pressures coming from Petrobras.[15]

Similarly, Sérgio Machado who was the CEO of the subsidiary Transpetro, revealed to prosecutors that he used to charge 1% of bribes for goods (such as oil tankers) but 3% for services. In many cases, shipyards who were built following the LC industrial policy actually delayed payments of bribes as they were suffering operational losses. For instance, the EAS shipyard was built only after winning an order from Transpetro to deliver ten "Suezmax" ships. However, due to productivity problems, the first Suezmax was delayed by 623 days and this resulted in contractual fines to the firm. According to Machado's plea bargain, the owners of the shipyard, the business groups Queiroz Galvão and Camargo Corrêa, pressured for contract renegotiations so Petrobras could absorb the losses and

[15] This is detailed in his "Collaboration Agreement" dated of 11/20/2014 with the police and public prosecutors, originally confidential, and his public statements made on 03/10/2015 to the *CPI da Petrobras* and in 11/19/2015 to the *CPI Fundos de Pensão*.

they offered in exchange more bribes. The request was denied and shareholders of EAS had to bear the losses, which already sums to over a $1 billion in the shipyard's operation (Lima-de-Oliveira 2016).

The evidence so far suggests that the upstream, even with a LC policy, was not associated with higher bribe rates. The corrupt behavior actually matches political economy models that predict optimal bribe rate subject to market constraints and monitoring capabilities – and LC upstream contracts are subject to forces that likely constrain rent-seeking. First, goods are priced in the international market, so price monitoring is easier, and large disparities are more likely to trigger suspicions from auditing agencies, shareholders, and the employees of the company who are not part of the scheme. Second, local suppliers are still in their learning curve trying to match more competitive producers, so their lower efficiency means that there is less rents to be shared[16]. Finally, the LC applies to all oil companies operating in E&P in Brazil, including international majors like Chevron, Shell and Statoil. Some companies operate directly production platforms while others have partnerships with Petrobras in developing specific fields and sit in the board of investment decisions, including in the highly productive fields of the pre-salt area. Therefore, investment in the upstream are commonly taken together with other partners, making it harder to conceal bribes, or is done directly by other companies. On the other hand, Petrobras' monopoly in the downstream meant that investment decisions were taken solely by the company, a practice that facilitated over-invoicing and political influence.

The investigations revealed that part of the bribes were paid as official campaign donations. To investigate how donations differed between suppliers and non-suppliers of Petrobras, table 3 shows the breakdown by the top five recipient parties of the total share of campaign donations made by firms for the general elections of 2006, 2010, and 2014 by these two distinct groups. The group of suppliers of Petrobras was obtained from the company's transparency portal and is made of 5067 distinct companies which had contracts of R$1 million or more between 2005 and 2015. Campaign donations data was obtained from Brazil's Superior Electoral Tribunal (TSE). It is possible to observe systematic differences in party preference of the Petrobras supplier donor group in favor of PT – the party which received the highest share of bribes, according to statements by collaborators in plea bargains. As for the weight of Petrobras' suppliers in the total amount of campaign donations made by firms, it increased from 5.6% (R$35 million) in 2006 to 8.2% (R$92 million) in 2010. In 2014, when the scandal

[16] Another evidence of this mechanism is that the only bribe rate for oil platforms above 1% in the Barusco dataset comes from the Keppel Fels shipyard, from Singapore, which opened a manufacturing plant in Brazil, bringing their own expertise in this business. All other shipyards are owned by Brazilian companies.

was already known, it stayed practically the same: 8.1% (R$105 million), but the PT preference reached its peak in comparison to the donation behavior of non-suppliers. While this data does not allow for distinguishing suppliers in the downstream from the upstream, it highlights the increased links between contractors and the main party of the ruling coalition. The data is also in line with previous studies of campaign donations in Brazil and PT's dominance within public contractors (Boas et al. 2014).

Table 3: Campaign donations from Petrobras suppliers and non-suppliers

Top five parties	Petrobras suppliers		All other donors		Difference on share of group donations
	Share of total donations	Amount in R$	Share of total donations	Amount in R$	
			2006		
PT	23.10%	BRL 8,303,820.70	11.30%	BRL 68,340,149.54	11.80%
PSDB	20.02%	BRL 7,198,432.69	20.34%	BRL 123,045,146.36	-0.31%
PMDB	19.41%	BRL 6,976,911.86	21.80%	BRL 131,869,157.56	-2.39%
PFL	12.30%	BRL 4,423,564.85	12.88%	BRL 77,919,069.07	-0.57%
PP	5.04%	BRL 1,812,000.00	6.02%	BRL 36,407,369.87	-0.98%
			2010		
PT	26.34%	BRL 24,468,418.50	17.55%	BRL 180,299,366.67	8.79%
PSDB	19.49%	BRL 18,102,139.90	19.47%	BRL 200,053,678.20	0.01%
PMDB	16.48%	BRL 15,308,640.35	17.55%	BRL 180,290,144.36	-1.07%
DEM	8.39%	BRL 7,796,761.00	7.91%	BRL 81,296,485.13	0.48%
PP	6.05%	BRL 5,619,901.00	4.91%	BRL 50,466,654.88	1.14%
			2014		
PT	58.64%	BRL 62,056,500.00	32.88%	BRL 392,579,395.89	25.75%
PSDB	11.35%	BRL 12,007,380.00	14.49%	BRL 173,039,281.56	-3.15%
PMDB	8.36%	BRL 8,846,365.53	12.88%	BRL 153,760,895.75	-4.52%
PSB	4.32%	BRL 4,575,671.05	6.03%	BRL 71,942,967.47	-1.70%
PP	4.17%	BRL 4,411,000.00	4.03%	BRL 48,137,430.52	0.14%

Source: Author's calculation based on Petrobras and TSE

4.3. Political use of Petrobras' investments

Starting with Luiz Inácio Lula da Silva's tenure in 2003, Petrobras was used as a tool to pursue industrial policy and regional politics, such as allocating investments of refineries and petrochemicals in states governed by political allies. This was not concealed – in several speeches and interviews President Lula and the then minister of Mines and Energy, Dilma Rousseff, praised Petrobras for decentralizing and

boosting its investment.[17] Furthermore, Petrobras' successful track record of discoveries opened up the possibility of becoming a net exporter in the medium-run, which had the double effect of spurring optimism concerning new investments and opening more financing opportunities. A major example was Petrobras' commitment to construct four new refineries at the same time – all in states governed by political allies (Rio de Janeiro, Pernambuco, Ceará and Maranhão). This would add an additional capacity of 1.3 million bpd in a few years – more than half of the refining capacity of 2013 of 2.124 million bpd spread in a park of 12 refineries that took decades to build (Petrobras 2013).

Unsurprisingly, these projects were rushed to fit political deadlines and served as stage for ribbon-cutting ceremonies followed by political speeches. Actual execution, however, suffered from project deficiencies and cost overruns. A major example is the Abreu e Lima refinery, in the state of Pernambuco. It was launched in 2005 as a joint-project with the Venezuelan PDVSA with an original budget of $2.5 billion. As a symbol of regional integration and proximity with the administration of Hugo Chávez, then president of Venezuela, the Abreu e Lima refinery would be constructed by Petrobras but jointly run and designed to process half of Brazilian oil and half of Venezuelan extra heavy crude oil. This required a more complex engineering due to the distinct characteristics of the two sources of oil and the solution was to construct two processing units in the same site, each customized to one type of oil.

In 2006, the planned capacity of the unit was increased from 150 thousand bpd to 230, with a new budget set at $4 billion. In the following year, Petrobras approved an acceleration plan to speed up the construction of the unit and have it partially concluded by August 2010 – just two months before general elections and Rousseff's first presidential bid. Acceleration implied relaxing some constraints and best practices, such as bidding for services and equipment only when a detailed engineering project is concluded. Contracting without a final engineering project can lead to renegotiations due to scope changes, increasing the room for corruption or plain inefficiencies.

Budget estimates of the unit kept rising and PDVSA, which suffered from its own cash and management problems, ended up never investing in the project. This led Petrobras to undertake the project alone and discard all the engineering work designed to process the Venezuelan oil. The refinery was only inaugurated in December of 2014, at the height of the corruption investigations and without any public ceremony. The cost reached $18.5 billion, and with only half of the operational capacity. The

[17] President Lula even claimed that the government pressured Petrobras to invest in refineries as part of the government's countercyclical investments after 2008, over objections of the company's executives (*Valor* 09-17-2009).

board of the company recognized that the unit will never be profitable – in fact, the lifetime return on investment is $3.2 billion negative.[18]

The Abreu e Lima project is emblematic of political meddling. First, the company was used to serve a foreign relations priority which was establishing close ties between Venezuela and Brazil, as desired by presidents Lula da Silva and Hugo Chávez. Second, the project was accelerated to coincide with the electoral period, compromising the internal rules of compliance and best practices. Unfortunately, the Abreu e Lima project was hardly alone in these respects. Even higher losses were registered for the Comperj refinery project in Rio de Janeiro. In Maranhão and Ceará, where two refineries were announced in 2010, Petrobras spent millions in political events and in preparing the infrastructure of the host sites until it was forced to cancel the projects in the third quarter of 2014, with write-downs of R$2.8 billion in its assets.

Losses in refineries accounted for most of the impairment impact in the total assets of Petrobras, recognized in the 2014 audited financial statements. Total losses were of R$44.6 billion, with refineries responsible for R$31 billion (~70%) and the rest spread into petrochemicals and exploration and production projects in Brazil and in the US Gulf of Mexico. Thus, the R$31 billion (roughly $10 billion) can be attributed to mismanagement and inefficiencies, in good part motivated by political factors. Another source of loss in the downstream originated from a growing price gap between the domestic gasoline price and the international price, analyzed next.

4.4. Price subsidies

While Brazil has found immense new oil reserves in the last years, development of the technically challenging ultra-deep reservoirs takes time to reach production stage – up to ten years from the exploratory phase. Geological abundance is known to exist, but actual output had been below the country's consumption needs – making Brazil a net importer of oil throughout the period under analysis, but on the verge of being a net oil exporter.

Traditionally, domestic prices of oil products (gasoline, diesel, etc.) were determined directly by the federal government, which at times preferred to subsidize prices in order to sustain industrial output or please voters. A mechanism called "oil-account" preserved the cash flow of Petrobras by

[18] See "Refinaria Abreu e Lima dará prejuízo de US$3,2 bi," Folha de São Paulo, 01/18/2015.

registering the cost of the subsidy in an account that had to be paid by the government using budget resources. In 2002, marking the last stage of the market opening reforms initiated in 1995, the prerogative of having the federal government directly setting prices of oil products was abolished and the "oil-account" eliminated. Going forward, prices would be set by the board of Petrobras following international prices, with some lags to insulate the domestic market from international volatility, thus converging in the medium-run. Private companies were free to open refineries or import oil products and sell it directly. However, Petrobras kept a monopoly position in the refinery park and all the port infrastructure to unload imports. Additionally, it never adopted a hard rule in determining price adjustment – the timing of price changes is arbitrarily determined by the board of the company. A monopoly position coupled with uncertainty in its price strategy created a substantive barrier of entry to potential competitors – and no other company decided to invest domestically in building new refineries nor setting consistent import operations.

Figure 5 plots a time-series of the price of gasoline in the US, the market that most closely reflects international fluctuations, with the price practiced in Brazil.[19] From the beginning of the series in 2001 up to the end of 2008 there is a strong correlation between the two prices: 0.93. Changes in domestic prices of gasoline in Brazil are a product of two main variables: price adjustments by Petrobras and exchange variations. Despite that, there is a clear trend of convergence between the domestic and international price, although occasional differences are sometimes substantive. Beginning in 2008 there is a decoupling of prices. After the 2008 financial crisis, commodity prices dropped drastically but consumers in the Brazilian market were forced to pay higher prices for 40 consecutive months, from November of 2008 to February 2012. Starting in the following month and ending only 39 months later, in November of 2014, domestic prices were below international markets. An adjustment only came on November 6, weeks after the second-round that reelected president Dilma Rousseff (PT) by just 3.4 p.p. of difference to Aecio Neves (PSDB), one of the tightest margins in Brazil's electoral history. Throughout Rousseff's administration from January 2010 to the end of 2015, price correlation fell to just 0.58 and tended to be below the US market price.

[19] Monthly domestic prices of retail gasoline in Brazil is from the Oil Regulatory Agency (ANP) and were converted to dollar. US data are from the Energy Information Agency (EIA) and was converted from gallon to liter. The comparison is intended to highlight convergence or divergence of trends, as the retail gasoline in Brazil is different from the US with respect to formulation. Brazil has a mandatory blend with ethanol of up to 27%, but also has the cheapest cost of production of ethanol in the world, at times cheaper than gasoline. Taxes on fuels in Brazil are higher than in the US and were removed for comparison purposes.

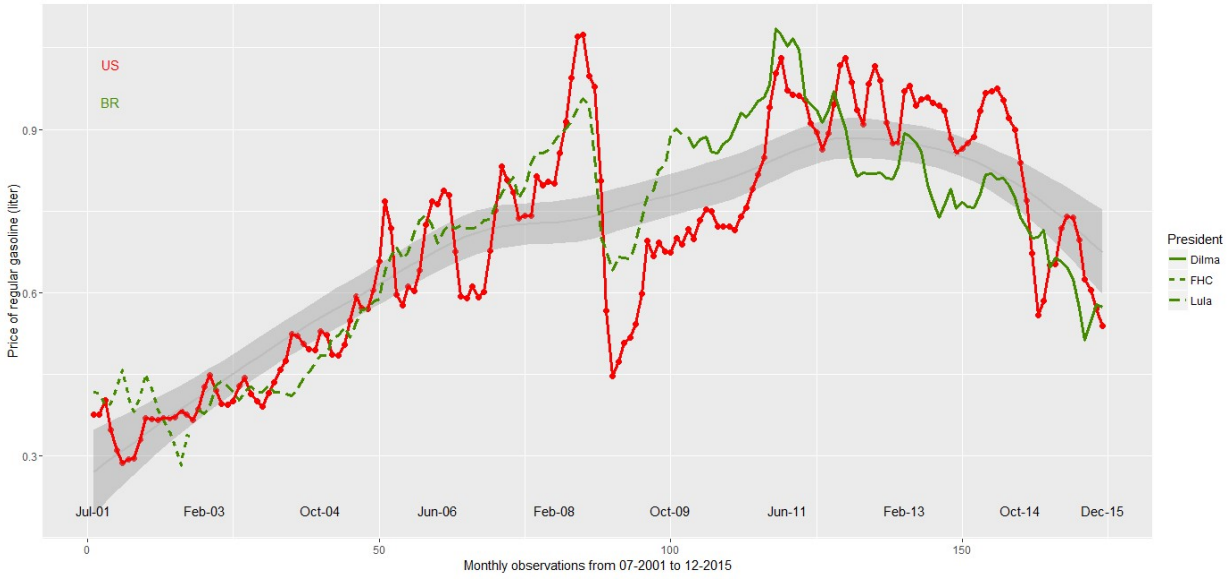


Figure 6: Price difference of gasoline in BR and in the US

Both periods – of price over and undervaluation – received intense coverage by the press and was widely known by market analysts and minority shareholders. Obviously, complains from shareholders focused on the latter effects. Antares Capital Management, a minority investor in Petrobras, complained formally twice to the Securities Commission of Brazil (CVM) against the practice. The investment company calculated losses of R$ 72 billion due to this practice, equivalent to $ 32 billion at the time the first complaint was registered (Fuzzetti 2013). Petrobras replied to CVM by claiming that it sought price convergence in the long-run and was not fined by the market regulatory agency nor by the board of the stock exchange.

In the course of a congressional investigation (*CPI da Petrobras)* the company was obliged to send confidential documents to lawmakers, including minutes and the audio of board meetings. These material were leaked to the press and reveal stark divisions between Petrobras employees, representatives of minority investors and board members appointed by the federal government. The leaked information disclosed Petrobras' own calculations of the losses due to price subsidies: R$80 billion ($35 billion)(Gaspar 2015). Sales of fuels account for half of Petrobras' revenues and it was losing money each time a consumer purchased gasoline or diesel during most of Dilma's government. This becomes evident in Table 3 that displays net profits of the two main segments of the oil company: the upstream and downstream. While the upstream was mostly in a positive rising trend, the downstream

shows a fourfold increase in net profits in 2009, when it was charging higher than the international prices, followed by a series of losses after 2011, reaching a peak in the electoral year of 2014. Finally, in 2015 the upstream segment suffered losses from impairment charges due to the fall of oil prices (which reduced the project revenues from Petrobras' high-cost deepwater fields), while the downstream regained profitability.

Table 3: Net profit per business segment (in million of R$)

Year	Upstream	Downstream
2003	$558	$599
2004	$15,796	$2,263
2005	$22,836	$5,545
2006	$24,763	$6,109
2007	$26,829	$5,908
2008	$37,615	$3,608
2009	$19,599	$13,332
2010	$29,691	$3,722
2011	$40,575	-$9,970
2012	$45,452	-$22,931
2013	$42,266	-$17,752
2014	$32,008	-$39,836
2015	-$12,963	$18,034

Source: Petrobras' financial statements

To finance these losses, Petrobras was burning cash reserves and increasing its total debt. State-owned federal banks provided a soft-budget constraint to Petrobras by increasing their funding to the company especially during the financial crisis of 2008-09, when the international banking system refrained from financing larger investments. As can be seen in Table 4, Petrobras' total debt rapidly increased, reaching R$ 492 billion in 2015, equivalent to $127 billion.

Debt financing was facilitated by the impressive investment program that the company was pursuing, mostly focused on developing the pre-salt reservoirs and building new refineries. Especially from 2009 onwards, the federal government used Petrobras as an instrument for Keynesian counter-cyclical investment, boosting the domestic demand in a time where the world was passing through tough economic times and limiting price adjustment to combat inflationary pressures. When state and federal taxes are added, Brazilian consumers do not pay lower gasoline prices in comparison to the

international market. In fact, for most of its history, Brazilians paid higher domestic prices in oil products as a cross-subsidy to finance Petrobras' exploratory campaign, particularly during the military regime (Randall 1993). However, after the discovery of the pre-salt oil area and the perspectives of future abundance, the company's cash became a honey pot for energy subsidies, which ended up representing the largest total loss of the politicization of the company.

Table 4: Petrobras' debt burden (in millions of R$)

Year	Total gross debt	Debt with public banks	%
2003	$60,498	$4,400	7.27%
2004	$52,756	$1,800	3.41%
2005	$48,242	$5,300	10.99%
2006	$46,605	$8,100	17.38%
2007	$39,741	$7,300	18.37%
2008	$64,713	$19,400	29.98%
2009	$102,450	$46,100	45.00%
2010	$117,915	$51,400	43.59%
2011	$155,554	$32,400	20.83%
2012	$196,314	$65,100	33.16%
2013	$267,820	$69,800	26.06%
2014	$351,035	$75,100	23.51%
2015	$492,849	$95,034	19.28%

Sources: Petrobras financial statements and author's calculations

5. Conclusion

Petrobras has been both a source of pride for Brazilians, given its technological prowess and leadership in deep offshore oil, and of shame, after a police operation revealed that the oil company was the center of a corruption scandal that involved contractors, senior managers and political parties. Brazil's oil company showed to be both innovative and highly capable of developing complex offshore projects and very corrupt – an unlikely combination for NOCs. This paper argues that innovation was key to create rents given Brazil's complex deep offshore oil resources. Innovation was thus supported through public sources of funds (oil rents earmarked to R&D in universities) and company's internal resources, even at the height of the large corruption scheme that started in 2004.

For most of its history, Petrobras was a NOC in a resource poor country. It had been traditionally spared from political interference in its management decisions and was seen as a "pocket of efficiency" in the Brazilian state (Oliveira 2012, Evans 1995). In its innovation activities, it worked in close contact with suppliers, particularly for developing customized solutions for deep offshore oil (Dantas and Bell 2011). These close collaborations with suppliers later facilitated bribe extraction by career employees, whose promotion to senior positions depended on the support of parties in the ruling coalition. The scheme involved contractors overcharging Petrobras through a cartel and its senior management gladly accepting over invoicing in order to receive kickbacks that ranged from 1% to 3%. As Petrobras reached successive records of production and discoveries, it became increasingly a target for politicians interested in extracting bribes and using it as a tool for distributive policies, which included industrial policies, regional development and subsidized gasoline prices.

However, bribe rates and financial losses varied widely between the industry segments of upstream (oil exploration and extraction) and downstream (refining and petrochemicals). I provide a theory that explains Petrobras' incentives towards innovation and where distributive and cost-pressures are highest in the oil firm. Using as data sources a spreadsheet of bribe rates of 88 large projects signed between 2003-2010, testimonies made in plea bargains, and financial records of Petrobras, this study shows that the upstream had lower bribe rates and generated more consistent positive economic results to the company than the downstream, in line with the theoretical expectations. Results highlight the importance of disaggregating activities by segment in order to judge the effects of distributive pressures and industrial policies in Brazil and elsewhere.

State companies, and NOCs in particular, are known to be used as instruments of short-term political objectives but not as drivers of innovation capabilities – in fact, the two goals are expected to be in conflict. In this regard, Petrobras stands out as an unusual case for its combination of technical capabilities and widespread party corruption. While in the Brazilian case corruption was facilitated by innovation, the reverse is not true. The evidence suggests that Petrobras can continue to be an innovative company and spared from party corruption if internal promotions and investment goals are shielded from political influence. The company would still have to deal with personal enrichment deviations, as was the case of Pedro Barusco. More generally, the future of the Brazilian oil industry would benefit from more competition in both the upstream and downstream segments. In a fully competitive environment, the government would not be able to control gasoline prices as it did, and the end of Petrobras' monopsony condition would reduce incentives for extracting bribes from suppliers.

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